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(54) [Title of the Invention]: Wafer Polishing Method and its Apparatus

(57) [Abstract]

[Object] To provide a method and an apparatus for polishing wafers that can efficiently control polishing to a high level of precision and that makes it possible to know the thickness of a film that is being polished without removing the wafer from the lathe while it is being polished.

[Configuration] Polishing solution is dripped onto the surface of the polishing pad 5 that has been affixed to the turning lathe 1. At the same time, the wafer 7, which is affixed to the wafer support plate 8, is turned and pressed by the wafer support plate 8, which polishes the wafer. The polished condition is judged by monitoring a spectral reflectivity measuring device or an imaging display using an imaging device that has a charged coupled device to view the state of the light that is reflected from the polished surface of the wafer 7 from the clear window 4, which is located between the lathe 1 and the peripheral edge and center of rotation of the polishing pad 5.

[See source for diagram.]

5 Polishing Pad	2 Groove		8 Wafer Support Plate			
				7 Wafer 6 Polishing Pad Window		
1 Lathe			3 Hole	4 Clear Window Material 9 Probe 10 Optical Cable		

**[Scope of Patent Claims]**

[Claim 1] A wafer polishing method in which polishing solution is dripped onto the surface of a turning lathe that is covered with a polishing pad, while a wafer that is affixed to the wafer support plate is polished by pressing and turning the wafer support plate. In this method, the state of the reflected light is viewed from the window between the lathe and the peripheral edge and center of rotation of the polishing pad in order to determine the state of the polishing.

[Claim 2] The method described in Claim 1 in which the light's reflected state is viewed with an imaging display device and an imaging device that uses a charged coupled device.

[Claim 3] The method described in Claim 1 in which the state of the light's reflected state is viewed using a spectral measuring device.

[Claim 4] A wafer polishing device that is equipped with the following. A lathe that is turned by a rotation device, a polishing pad that is affixed to the surface of the lathe, a wafer support plate that is turned by the rotation device and is placed so that it can move in the axial direction in opposition to the polishing pad between the center and the peripheral edge of the lathe, a groove that extends in the radial direction on the surface where the polishing pad is affixed between the center and the peripheral edge of the lathe, a polishing pad window made in the polishing pad that matches said groove, a hole in the aforementioned groove in the lathe, a clear window that closes off said hole, a probe that receives the reflection of the light that is projected onto the polished surface of the wafer that is fixed to the wafer support plate through the aforementioned clear window, an optical cable that is connected to said probe, a device that is connected to the optical cable and supplies light to the optical cable and a device for observing or evaluating the reflected light.

[Claim 5] A wafer polishing device that is equipped with the following. A lathe made of clear materials that is turned by the rotation device, a polishing pad that is affixed to the surface of the lathe, a wafer support plate that is turned by the rotation device and place so that it can move in the axial direction in opposition to the polishing pad between the center and the peripheral edge of the lathe, a groove that extends in the radial direction in the surface where the polishing pad is affixed between the center and the peripheral edge of the lathe, a polishing pad window in the polishing pad that matches said groove, a probe that receives the reflection of the light that is projected onto the polished surface of the wafer that is fixed to the wafer support plate through the aforementioned lathe, an optical cable that is connected to said probe, a device that is connected to the optical cable and supplies light to the optical cable and a device for observing or evaluating the reflected light.

[Claim 6] The wafer polishing device described in Claims 4 or 5 in which the groove in the lathe is shaped and bordered by two nearby straight lines that extend radially from the center.

[Claim 7] The wafer polishing device described in any of Claims 4, 5 or 6 in which the device for viewing the reflected light is made up of an imaging display device and an imaging device that uses charged coupled devices.

[Claim 8] The wafer polishing device described in any of Claims 4, 5 or 6 in which the device for viewing the reflected light is a spectral measuring device.

**[Detailed Explanation of the Invention]****[0001]****[Technical Fields of the Invention]**

The present invention relates to a polishing device and a method for semiconductor wafers, and in particular, for SOI (Silicon on Insulator) wafers and other wafers with films.

**[0002]**

[Prior Art] In one widely used method of polishing semiconductor wafers using friction between the wafer and the polishing pad, a lathe that has a polishing pad affixed to its upper surface is turned and, while dripping polishing solution onto the polishing pad, a wafer that has been affixed to a wafer support plate is pressed while rotating, against the polishing pad using the wafer support plate. In this method, the amount of polishing normally is adjusted with the polishing time while strictly managing such conditions as the rpm of the lathe, the polishing load, the amount of polishing solution supplied and its temperature or the rpm and rocking of the wafer.

[0003] The average processing speed is calculated from the polishing time and the amount by which the wafer's thickness is reduced during polishing and used to determine the polishing time. With normal wafer polishing, there is no other method for measuring the processing speed and because variations of several percent in the processing speed caused by variations in the different conditions did not cause problems, this method was sufficient.

[0004] This polishing method is also applied in the case of wafers with films. Compared with the polishing of normal wafers, there is a smaller range of tolerance in the variation of the amount of polishing, so when attempts are made to control the amount of processing using the polishing time, very strict process management is required since even very slight changes in the processing speed cannot be allowed. Adjusting the film thickness is the principal purpose with this sort of polishing and controlling the amount of polishing is nothing more than a means of accomplishing that. Since the film thickness can be learned by using visual observation of interference stripes or through optical measurements, it is common, in experimental polishing, to interrupt the polishing occasionally to check the film thickness and determine when to stop polishing.

**[0005]**

While this method is a safe one with few failures, there are many problems where production is concerned. In other words, each time the polishing is interrupted the wafer has to be washed and dried, so the processing time per unit increases. The mechanism for automation is complex, which also pushes up polishing costs. Furthermore, as the time between interruptions decreases, the normal state of polishing and the conditions change, so the expected amount of polishing cannot be obtained, which can make control even worse.

[0006]

[Problems the Invention is to Solve] The present invention makes it possible to know the thickness of a film during polishing without having to remove the wafer from the lathe while it is being polished. Its purpose is to provide a wafer polishing method and device that can give polishing a high degree of precision and control, efficiently.

[0007]

[Means for Solving the Problems] The means for solving these problems with the present invention follow below.

(1) A wafer polishing method that determines the polished state as follows. While dripping polishing solution on a rotating lathe surface to which a polishing pad has been affixed, a wafer that is fixed to a wafer support plate is pressed against it and polished using the wafer support plate. With such methods, light is projected onto the polished surface of the wafer and the reflected light is observed from a window, located between the lathe and the center of rotation and the peripheral edge of the polishing pad, in order to determine the polished state of the wafer.

[0008] (2) The method described above where the reflected state of the light is viewed with an imaging device that uses a charged coupled device and its imaging display device or viewed with a spectral reflectivity meter.

[0009] (3) A wafer polishing device that is equipped with the following. A lathe that is turned by a rotating device, a polishing pad that is affixed to the surface of the lathe, a wafer support plate that is rotated by the rotating device and is placed so that it can move in the axial direction in opposition to the polishing pad between the peripheral edge and the center of the lathe, a groove that extends radially over the surface where the polishing pad is affixed between the center and the peripheral edge of the lathe, a polishing pad window in the polishing pad that lines up with said groove, a hole in the aforementioned groove of the lathe, a clear window material that closes said hole, a probe that receives the reflected light from the polished surface of the wafer that is affixed to the wafer support plate and illuminated with light passing through the clear window material described above and which is placed in the path of rotation of the hole on the opposite side of the surface that has the groove described above, an optical cable that is connected to said probe, a light-supplying device that supplies and is connected to the optical cable as well as a device for evaluation or for observing the reflected light.

[0010] (4) A wafer polishing device equipped with a lathe that is composed of clear materials that are turned by a rotation device, a polishing pad that is affixed to the lathe surface, a wafer support plate that turns by means of the rotation device that is placed so that it can move in the axial direction in opposition to the polishing pad between the center and the peripheral edge of the lathe, a groove that extends radially over the surface where the polishing pad is affixed between the center and the peripheral edge of the lathe, a polishing pad window made in the polishing pad that lines up with said groove, a probe that receives reflected light from the polished surface of the wafer that has been affixed to wafer support plate, which is illuminated by light passing through the aforementioned lathe, an optical cable that is connected to said probe, a light supply device that is connected to said optical cable and a device for evaluating or observing the reflected light.

[0011] (5) A wafer polishing device in which the groove made in the lathe is bordered by two nearby, straight lines that radiate out from the center.

[0012] (6) The devices described above in which the device for observing the reflected light is an imaging device that uses a charged coupled device and its imaging display device or the device for evaluating the reflected light is a spectral reflectivity metering device.

[0013]

[Effect] In the method of the present invention, if the state of the polishing is determined by observing the state of the reflection of the light on the polished surface of the wafer from the window that is located between the lathe and the center of rotation and the peripheral edge of the polishing pad, then the end point of the polishing state can be known without interrupting the polishing, which will shorten the time required for the polishing process and simplify the device. The reflected state of the light is captured with an imaging device that uses a charged coupled device (CCD), the sort of device used in video cameras, to capture the light that is reflected from the polished surface of the wafer, which is illuminated using an optical cable. This is then viewed on a CRT or other imaging display device. The interference stripes that appear on the imaging display device are used to determine the thickness. For film thicknesses of 2 μm or less, stripes are visible under old style fluorescent lights or incandescent lights and for thicknesses of 1 μm or less, rainbow colored stripes are visible under incandescent light.

[0014] Additionally, it is possible to know that the film has reached the desired thickness from the peak of a specific wavelength by illuminating the polished surface of the wafer with an optical cable and inputting the reflected light into a spectral reflectivity metering device. This decision on the polished state can be made while still polishing or after interrupting polishing temporarily. Even when stopping briefly, the length of time until the polishing was finished would be extremely short compared with the traditional method described above.

[0015] In the device of the present invention, reflected light from light projected onto the polished surface of a wafer through the film of the polishing solution between the clear window material and the wafer is observed or evaluated, but the polishing solution is a suspension of microgranules, which tend to scatter the light, so in terms of observations or evaluation, the smaller the gap between the polished surface of the wafer and the surface of the clear window material, the better.

[0016] The reason for making a groove that extends radially over the surface where the polishing pad has been affixed between the center and the peripheral edge of the lathe is that if a window is only made in the polishing pad, there is a chance that air will become mixed in with the polishing solution. Observations are difficult when air gets mixed in and the hole keeps air from getting mixed in by allowing the retention of sufficient polishing solution. In order to keep enough polishing solution in the groove, the groove and polishing pad window are in an area that doesn't contribute to the polishing process so it is necessary to choose a shape that will not disturb the distribution of the amount of processing within the wafer surface. It is advisable to

have two nearby straight lines that extend radially from the center of the lathe serve as a border so that the polished surface of the wafer can pass through the area from the center of the lathe to the periphery simultaneously.

[0017] With this sort of shape, if the wafer is subject to a pressurized load during polishing and rides up onto a non-pressurized part of the polishing pad from a pressurized part of the polishing pad, it will not get caught on the polishing pad window, but can ride over the depressions instead of the polishing pad window and ride up smoothly onto the polishing pad.

[0018] Any position or shape may be used for the clear window in the groove. When the center of the wafer is sufficiently representative for observations or measurements, the clear window may be positioned under the center of the wafer's rotation.

[0019] When the lathe is made of some material that does not admit light, such as aluminum, a hole may be made in the lathe and a clear window used to keep the polishing solution from leaking out and to allow the light to pass through as described above. However, when the lathe is made from materials that allow light to pass through, there would be no need for holes or clear windows. Nevertheless, in order to keep the gap between the polished surface of the wafer and the bottom of the groove small, it would be advisable to make the bottom of the groove as high as the area where the light is to pass through.

[0020] Light is projected onto the polished surface of the wafer and it is not a problem to stop the polishing to observe or evaluate the light that is reflected with a probe, but when making such observations or evaluations while polishing, the window in the lathe that allows the light through will be turning as will the wafer itself, so when time is needed to observe or evaluate a specific place on the wafer precisely, it is advisable to move the probe back and forth in the same rotation path as the window that allows the light of the pass at the same speed as the wafer is turning.

[0021] When evaluating the film thickness using a spectral reflectivity metering device, the film thickness can be calculated for each measurement which allows the final polishing to be determined precisely. Without calculating the film thickness while polishing, the spectral reflectivity may be calculated in advance for the target film thickness and polishing stopped when the measured spectral reflectivity matches the calculated values.

[0022]

[Embodiments] We will explain the embodiment shown in Figures 1 and 2. Lathe 1 is an aluminum disk with a diameter of 300 mm and a thickness of 10 mm. On one side is the fixed spindle that turns the lathe 1. In the surface on the side opposite the fixed spindle of the lathe 1 are two nearby straight lines that extend radially from the center. Groove 2 extends from near the center to near the peripheral edge. The center side of the groove 2 has a width of 5 mm and 15 mm at the periphery. It is 1 mm deep. Lengthwise and in the center of groove 2 is a hole 3 that is 10 mm in diameter. On the opposite side of groove 2, the hole expands in a cone shape. The Pyrex glass window 4 has been inserted into the hole 3 in the groove 2 side so that polishing solution will not leak out.

[0023] The polishing pad 5, which is the same shape as the lathe 1, is 0.7 mm thick and made of non-woven polyester soaked in a product called suba-500 urethane. It is affixed to the surface of the lathe 1 where the groove 2 is. The area corresponding to the groove 2 has been cut away in the same shape, forming the polishing pad window 6. The transparent window material 4 protrudes 0.5 mm farther than the surface of the lathe 1, but even considering the elasticity of the polishing pad 5, it is sufficiently lower than the surface of the polishing pad 5.

[0024] Light is projected onto the polished surface of the wafer 7 to be polished and facing the rotation path of the clear window 4 on the side opposite the groove 2 in the lathe 1. Probe 9 is positioned so that it picks up that reflected light. Probe 9 has a built-in focusing lens and is connected to the optical cable 10. The other end splits into two cables, one of which is connected to a measuring-use light source, the other to a spectral reflectivity metering device not featured in the diagram.

[0025] On one side, fixed to the rotation-use spindle is the disk-shaped, aluminum, wafer support plate 8 that is 10 mm thick and 110 mm in diameter. Two silicon wafers with thermal oxide films formed on their surfaces have been set in place with the thermal oxide films in contact. One of the wafers is ground flat to make an SOI wafer having a silicon film with a thickness of 15  $\mu\text{m}$  and a diameter of 100 mm. the surface that has not been ground flat is affixed using wax.

[0026] An alkali solution containing silica powder with a granularity of 0.01  $\mu\text{m}$  or less, produced by Rodel Nitta and called NALCO-2350, was diluted 20 times to produce a polishing solution that was dripped continually onto the surface on polishing pad 5 on the lathe 1. We turned the lathe 1 at a speed of 50 rpm and the wafer holder plate 8, to which was affixed the wafer 7, at a rate of 40 rpm. We positioned the center of rotation on the polishing pad 5 so that it would be over the clear window 4 and, pressing at a polishing load of 10 kgf, we began to polish to the target thickness of 1  $\mu\text{m}$ .

[0027] Under these conditions, the linear motion speed of the clear window 4 is approximately 500 mm per second, so the time in which the center of wafer 7 can be measured through the window 4, which has a diameter of 10 mm is approximately 10 msec for each passage. This amount of time is sufficient for a wavelength range of 680 ~ 800 nm and spectral reflectivity metering with a resolution of 1 nm. For a measurement reference point, we used a silicon wafer under the same conditions.

[0028] When polishing was started the spectral reflectivity of the film exhibited the same spectrum as the silicon wafer, however, as the polishing proceeded, we observed changes in the periodicity with respect to the wavelength of the reflectivity and the amplitude gradually increased. The individual peaks of the intensity of the reflected light reduced their shared gaps as they shifted to the shorter wavelength side. The shift in individual peaks led to a trading off of the peaks within the range of measured wavelengths and the gaps between peaks gradually widened.

[0029] According to our calculations, the spectral reflectivity of a silicon film with a 1  $\mu\text{m}$  thick SOI has a wavelength of 700 nm and a peak of 770. When the position of one of the peaks fell below 700 nm, we read the position of the next peak and when they reached 765 nm or more, we stopped polishing. If they were less than 765 nm, we continued polishing while tracking that position.

[0030] After polishing 10 SOI wafers in this way, we were able to keep the median film thickness in the range of 0.98 ~ 1.00  $\mu\text{m}$  for all of the wafers. The time required for polishing was in the range of 30 ~ 45 minutes.

[0031]

[Comparative Examples] We polished identical SOI wafer silicon films under the same conditions as the embodiment. The mid-point measurements of the film thickness were carried out through observations as follows. 1. We stopped the supply of the polishing solution and, after running purified water over the polishing pad, we stopped the rotation of the lathe and the wafer support plate. 2. We lifted up the wafer and the wafer support plate, rinsed them with purified water and then removed the excess water. 3. The light source that had illuminated the surface was projected onto the wafer for observations. 4. We observed the film thicknesses using the following as a guide. 5. a) When the polishing was complete, the wafer was removed from the wafer support plate. b) When thicker than the target, polishing was resumed. After a specific amount of time, we went back to step 1.

[0032] Guide to Judging Film Thickness based on Observations of Interference Stripes

Stripes appear hazy under sodium lamp illumination:

8 ~ 10  $\mu\text{m}$  or less.

" clear "

5  $\mu\text{m}$  or less

Stripes visible under 3-wavelength light-emitting fluorescent lamp illumination:

3  $\mu\text{m}$  or less

Visible even under old-type fluorescent light or incandescent light:

2  $\mu\text{m}$  or less

Rainbow colors visible under white light (normal illumination):

1  $\mu\text{m}$  or less

[0033] The net polishing time was 30 ~ 40 minutes, but the polishing was interrupted 2 ~ 4 times per wafer to measure the film thickness. For this reason, the average polishing time ran one hour. Based on the results of the film thickness measurements, we determined when to stop polishing in 10-second units. Ultimately, however, the median wafer film thickness distribution was in a range of 0.9 ~ 1.1  $\mu\text{m}$ . Additionally, there was no improvement in the control even when we fine-tuned the stopping point for the polishing. This seemed like the precision limit on conventional polishing methods.

[0034]

[Effect of the Invention] The present invention makes it possible to control polishing efficiently with a high degree of precision because it is possible to know the film thickness while polishing without removing the wafer from the lathe while polishing it.

[Brief Explanation of the Drawings]

[Figure 1] is a partial cross-section side view of the device of the present invention.

[Figure 2] is a partial flat diagram of the lathe 1.

[Description of Numbers and Symbols]

- 1 Lathe
- 2 Groove
- 3 Hole
- 4 Clear window
- 5 Polishing pad
- 6 Polishing pad window
- 7 Wafer
- 8 Wafer support plate
- 9 Probe
- 10 Optical cable

[Figure 1]  
[see source for diagram]

	2 Groove		8 Wafer support plate			1 Lathe	
5 Polishing pad				7 Wafer 6 Polishing pad window			
1 lathe		3 Hole	4 Clear window 9 Probe 10 Optical cable			2 Groove	4 Clear window

[Figure 2]  
[see source for diagram]

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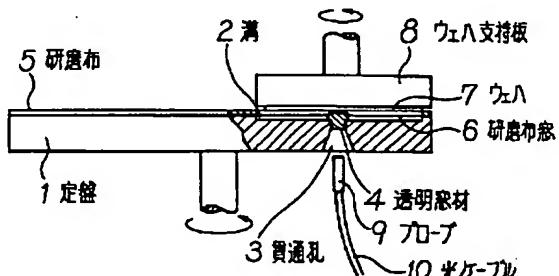
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(54)【発明の名称】 ウエハ研磨方法及びその装置

(57)【要約】

【目的】 研磨途中でウエハを定盤から離すことなく研磨中の膜の厚さを知ることができ、研磨の高精度な制御が効率よくできるウエハの研磨方法及び装置を提供する。

【構成】 回転する定盤1の研磨布5の張り付けられた面に、研磨液を滴下しつつ、ウエハ支持板8に固定したウエハ7をウエハ支持板8により回転させつつ押し付け研磨する方法において、定盤1及び研磨布5の回転中心と周縁との間に設けた透明窓4からウエハ7の研磨面の光の反射状態を電荷結合素子を用いた撮像装置とその撮像表示装置や分光反射率測定装置で見て研磨状態を判定しつつ研磨する。



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## 【特許請求の範囲】

【請求項1】 回転する定盤の研磨布の張り付けられた面に、研磨液を滴下しつつ、ウエハ支持板に固定したウエハをウエハ支持板により回転させつつ押し付け研磨する方法において、定盤及び研磨布の回転中心と周縁との間に設けた窓からウエハの研磨面の光の反射状態を見て研磨状態を判定するウエハ研磨方法。

【請求項2】 光の反射状態を電荷結合素子を用いた撮像装置とその撮像表示装置によって見る請求項1に記載の方法。

【請求項3】 光の反射状態を分光反射率測定装置で見る請求項1に記載の方法。

【請求項4】 回転装置により回転する定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝内に設けた貫通孔と、該貫通孔を閉じる透明窓材と、定盤の前記溝を有する面の反対側で貫通孔の回転路に臨ませ配置した、前記の透明窓材を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置。

【請求項5】 回転装置により回転する透明な材料からなる定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝を有する面の反対側で前記の溝に臨ませ配置した、前記定盤を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置。

【請求項6】 定盤に設けた溝が、中心から放射状に伸びる近接した2本の直線に囲まれた形状をなしている請求項4又は5に記載のウエハ研磨装置。

【請求項7】 反射光観察装置が電荷結合素子を用いた撮像装置とその撮像表示装置とからなる請求項4、5、6の何れか一つに記載のウエハ研磨装置。

【請求項8】 反射光評価装置が分光反射率測定装置である請求項4、5、6の何れか一つに記載のウエハ研磨装置。

## 【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、半導体ウエハ、特にS

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O I (Silicon-on-Insulator)ウエハ等の膜付きウエハの研磨方法及び装置に関する。

【0002】

【従来の技術】 半導体ウエハ研磨では、上面に研磨布が張り付けられた定盤を回転させ、研磨布上に研磨液を滴下しながら、研磨布にウエハ支持板に固定したウエハを、ウエハ支持板により回転させつつ押し付けて、ウエハと研磨布との摩擦により研磨を進行させる方法が広く用いられている。この方法において、研磨加工量は通常、定盤の回転速度、研磨荷重、研磨液の供給量及びその温度、ウエハの回転及び振動、等が厳しく管理された条件下で、研磨時間によって調節される。

【0003】 研磨によるウエハ厚さの減少量と研磨時間とから平均の加工速度を求め、研磨時間の決定に用いる。通常のウエハ研磨においては、加工速度の測定はこの方法以外なく、又諸条件の変動がもたらす数%の加工速度の変動は実用上支障がないので、この方法で十分であった。

【0004】 膜付きウエハにもこの研磨方法が適用される。通常のウエハの研磨と比較すると、研磨加工量の変動の許容幅が小さいので、研磨時間で加工量を制御しようとすれば、加工速度のわずかな変動も許さないような厳しい工程管理が必要となる。この種の研磨では膜の厚さの調節がその主な目的であって、研磨加工量の制御はその手段に過ぎない。膜の厚さは肉眼による干渉線の観察あるいは光学的な測定によって知ることが出来るので、実験的な研磨では、研磨を時々中断して、膜厚を確認しながら研磨終了の時期を決めるのが一般的である。

【0005】 この方法は失敗の少ない安全な方法であるが、生産のための方法としては問題が多い。即ち、研磨を中断する度にウエハの洗浄、乾燥が必要なため、1枚当たりの処理時間が長く、自動化のための機構が複雑となり研磨費用が高くなる問題がある。又、中断と中断の間の時間が短くなると、定常状態の研磨と条件が異なってくるため、予期した研磨加工量が得られず、かえって制御性が悪化してしまうという問題があった。

【0006】

【発明が解決しようとする課題】 本発明は、研磨途中でウエハを定盤から離すことなく研磨中の膜の厚さを知ることができ、研磨の高精度な制御が効率よくできるウエハの研磨方法及び装置を提供することを課題とする。

【0007】

【課題を解決するための手段】 本発明による課題を解決するための手段は、

(1)回転する定盤の研磨布の張り付けられた面に、研磨液を滴下しつつ、ウエハ支持板に固定したウエハをウエハ支持板により回転させつつ押し付け研磨する方法において、定盤及び研磨布の回転中心と周縁との間に設けた窓からウエハの研磨面の光の反射状態を見て研磨状態を判定するウエハ研磨方法。

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【0008】(2)光の反射状態を電荷結合素子を用いた撮像装置とその撮像表示装置で見るか、分光反射率測定装置で見る上記の方法。

【0009】(3)回転装置により回転する定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝内に設けた貫通孔と、該貫通孔を閉じる透明窓材と、定盤の前記溝を有する面の反対側で貫通孔の回転路に臨ませ配置した、前記の透明窓材を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置。

【0010】(4)回転装置により回転する透明な材料からなる定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝を有する面の反対側で前記の溝に臨ませ配置した、前記定盤を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置。

【0011】(5)定盤に設けた溝が中心から放射状に伸びる近接した2本の直線に囲まれた形状をなしているウエハ研磨装置。

【0012】(6)反射光観察装置が電荷結合素子を用いた撮像装置とその撮像表示装置とからなるか、反射光評価装置が分光反射率測定装置である上記の装置、にある。

【0013】

【作用】本発明方法において、定盤及び研磨布の回転中心と周縁との間に設けた窓からウエハの研磨面の光の反射状態を見て研磨状態を判定すれば、研磨を中断せずに研磨状態の終点を知ることが出来るので、研磨処理の時間を短くでき、装置も簡単で済む。光の反射状態は、光ケーブルでウエハの研磨面に光を照射してその反射光をビデオカメラに用いられている電荷結合素子(CCD)を用いた撮像装置で取り、これをブラウン管などの撮像表示装置で表示せしめ、撮像表示装置に現れた干渉縞により厚さを判断する。膜厚の場合、2μm以下では旧型の蛍光灯や白熱灯で縞が見え、1μm以下では白色灯では虹色の縞が見える。

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【0014】又、光ケーブルでウエハの研磨面に光を照射してその反射光を分光反射率測定装置に入れ、特定の波長のピークにより所望の厚さになったことを知る。この研磨状態の判定は、研磨中に行っても、研磨を一時停止して行ってもよい。一時停止しても前記の従来の方法よりも研磨終点までの時間は極めて小さくできる。

10 【0015】本発明の装置において、透明窓材とウエハとの間にできる研磨液の膜を通してウエハの研磨面に照射した光の反射光を観察あるいは評価するのであるが、研磨液は液中に微粒子が懸濁したものであり、光を散乱する性質をもっているので、透明窓材の表面とウエハの研磨面との間の間隔が小さい方が観察あるいは評価に都合がよい。

【0016】定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長した溝を設けるのは、研磨布にだけ研磨布窓を設けたのでは、研磨液に空気が混じる恐れがあり、空気が混じると観察が困難となるので、研磨液を十分保持できるようにし、空気が混じらないようにするために溝に研磨液を十分保持させるため、この溝や研磨布窓は研磨加工に寄与しない領域となるので、ウエハ面内の加工量分布を乱さない形を選ぶ必要があり、定盤の中心から周辺にウエハの研磨面が同一時間で通過するように、定盤の中心から放射状に伸びる近接した2本の直線に囲まれるようにするのがよい。

【0017】このような形状とすれば、研磨中にウエハが圧縮荷重を受けて圧縮されている研磨布上から圧縮されていない研磨布の部分に乗り上げる時に、研磨布窓に引っ掛かったりしないで、研磨布窓よりくぼみを乗り越えて滑らかに研磨布に乗り上げることができる。

20 【0018】透明窓材の溝における位置及び形状は任意である。観察または測定をウエハの中心で代表させて良い場合には、透明窓材の位置をウエハの回転中心の下に位置させてもよい。

【0019】アルミニウムのような光の透過しない材料で定盤が作られている時は上記のように、定盤に貫通孔を設けて研磨液が漏洩しないように透明窓材で貫通孔を開じて光を通過させるようにするが、透明ガラスのような光の通過する材料で定盤が作られているときは、貫通孔や透明窓材を必要としない。しかし、ウエハの研磨面と、溝底との間隔を小さくするために、光を透過させる部分だけ溝底を高くするのがよい。

40 【0020】光をウエハの研磨面に照射しその反射光を受けるプローブは、研磨を停止して観察又は評価を行う場合は問題はないが、研磨中に観察又は評価を行う場合、定盤の光通過窓は回転しており、ウエハも自転しているので、ウエハの特定場所を正確に観察又は評価するのに時間を必要とするときは、ウエハの自転速度と同じ速度でプローブを光通過窓と同じ回転路において往復運動させねばよい。

50 【0021】分光反射率測定装置で膜厚の評価を行う場

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合には、測定毎に膜厚を計算で求めることが出来るので、研磨の終点を正確に決定できる。研磨中に膜厚計算を行わず、膜が目標の厚さになったときの分光反射率を予め計算で求めておいて、測定した分光反射率の特徴が計算と一致した時点で研磨を終了してもよい。

## 【0022】

【実施例】図1、図2に示した実施例について説明する。定盤1は直径300mm、厚さ10mmのアルミニウム製の円盤で、その中心の片面に定盤1を回転するための軸が固定してある。定盤1の軸を固定した面の反対側の面には、中心から放射状に伸びる近接した2本の直線で囲まれ、中心付近から周縁近くまで伸びた溝2が設けてある。溝2の中心側の幅は5mmで周縁側の幅は15mm、深さ1mmとなっている。溝2の長手方向中央には、直径10mmの貫通孔3が設けられ、溝2の反対側では円錐状に拡大している。貫通孔3の溝2側にはバイレックス透明ガラス製の透明窓材4が嵌め込まれ、研磨液が漏れないようにしてある。

【0023】定盤1の溝2を有する面には、定盤1と同形の厚さ0.7mmのローデルニッタ社製、商品名suba-500ウレタン含浸ポリエステル不織布からなる研磨布5が張り付けられ、溝2に相当する部分は溝2と同形に切り抜かれて、研磨布窓6が形成されている。透明窓材4は定盤1の表面より約0.5mm突出するが、研磨布5の弾性を考慮しても研磨布5の表面より十分低くなっている。

【0024】定盤1の溝2の反対側には透明窓材4の回転路に面して研磨するウエハ7の研磨面に光を照射しその反射光を受光するプローブ9が配置されている。プローブ9はピント調節用レンズを内蔵し、光ケーブル10に接続され、その他端は二股に別れ図示していない分光反射率測定装置と測定用光源に接続されている。

【0025】片面に回転用の軸が固定された直径110mm、厚さ10mmの円盤状のアルミニウム製のウエハ支持板8に、表面に熱酸化膜を形成した2枚のシリコンウエハを、熱酸化膜を接せしめて接着し、一方のウエハを平面研削して厚さ15μmのシリコン膜として直径100mmのSOIウエハを、平面研削加工していない面をワックスで張り付けた。

【0026】粒径が0.01μm以下のシリカ粉末を含むアルカリ性溶液からなるローデルニッタ社製、商品名NALCO-2350を20倍に希釈した研磨液を定盤1の研磨布5の表面に滴下しつつ、定盤1を毎分50回転させな\*

干渉鏡の観察による膜厚判断の目安

ナトリウムランプ照射下で綫がぼんやり見える→8~10μm以下

"はっきり見える→5μm以下

3波長発光型蛍光ランプ照明下で綫が見える→3μm以下

旧型の蛍光ランプや白熱ランプでも見える→2μm以下

白色光下(普通の照明)で虹色を呈する。→1μm以下

【0033】正味の研磨時間は30~40分であった 50 が、ウエハ1枚につき2~4回研磨を中断して膜厚測定

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\*がら、ウエハ支持板8に張り付けたウエハ7を、自転速度毎分40回転で回転させつつ、研磨布5に、回転中心が透明窓材4の上に位置するように、研磨荷重10kgfで押し付けて目標膜厚を1μmにして研磨を開始した。

【0027】この条件では、透明窓材4の移動線速度は約500mm/秒なので、直径10mmの透明窓材4を通してウエハ7の中心を測定出来る時間は、1回の通過に付き約10m秒である。この時間は、波長範囲680~800nm、分解能1nmで行う分光反射率測定に対して十分であった。測定の参照基準には、同じ条件に置いたシリコンウエハを用いた。

【0028】研磨開始時、膜の分光反射率は、シリコンウエハと同一のスペクトルを示したが、研磨の進行に伴い反射率の波長に対する周期的な変動が現れ、徐々にその振幅を増した。反射光強度の個々のピークは相互の間隔を狭めながら短波長側へと移行した。個々のピークの移動により、測定波長範囲内のピークが入れ代わるつれて、ピークの間隔は次第に広がった。

【0029】計算によれば、SOIの厚さ1μmのシリコン膜の分光反射率は波長700nmと770nmにピークを持つ。そこで、一つのピークの位置が700nmを下回った時点で次のピークの位置を読み、それが765nm以上であれば研磨を終了するものとし、765nm未満であればその位置を追跡しながら研磨を続行した。

【0030】このようにして10枚のSOIウエハを研磨した結果、全てのウエハにおいて中心の膜厚は0.98~1.00μmの範囲に収まっていた。研磨の所要時間は30~45分の範囲にあった。

## 【0031】比較例

実施例と同様の条件で同一のSOIウエハのシリコン膜の研磨を行った。研磨途中での膜厚の測定は次のように観察により行った。1. 研磨液の供給を停止し、研磨布に純水をかけ流した後、定盤及びウエハ支持板の回転を停止する。2. ウエハをウエハ支持板ごと取り上げ純水でゆすいで水を切る。3. 照明に照らされた面光源にウエハを映して観察する。4. 下記の目安で膜厚を観察する。5. a)研磨終了の場合、ウエハ支持板からウエハを外す。b)目標より厚い場合は、研磨を再開、所定時間の後1.へ

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を行ったため、平均の研磨時間としては1時間要した。膜厚測定の結果を元に10秒単位で研磨終了の時期を決めたが、最終的にウエハ中心の膜厚は0.9~1.1 μmの範囲に分布した。又、研磨終了時期をこれより細かく調節しても制御性が良くなることはなく、従来法の研磨の限界精度と考えられた。

【0034】

【発明の効果】本発明によれば、研磨途中でウエハを定盤から離すことなく研磨中の膜の厚さを知ることができるので、研磨の高精度な制御が効率よくできる。

【図2】図1の定盤1の一部平面図である。

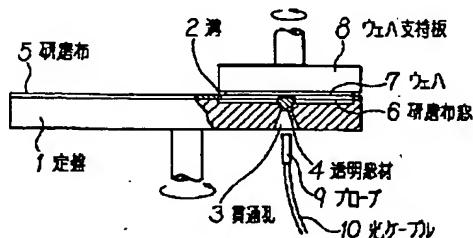
【符号の説明】

- 1 定盤
- 2 溝
- 3 貫通孔
- 4 透明窓材
- 5 研磨布
- 6 研磨布窓
- 7 ウエハ
- 8 ウエハ支持板
- 9 プローブ
- 10 光ケーブル

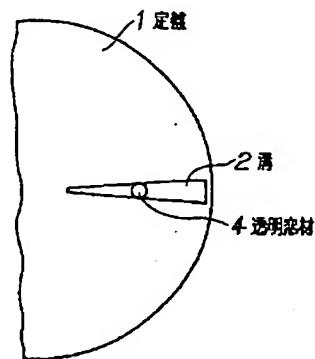
【図面の簡単な説明】

【図1】本発明装置の一部断面側面図である。

【図1】



【図2】



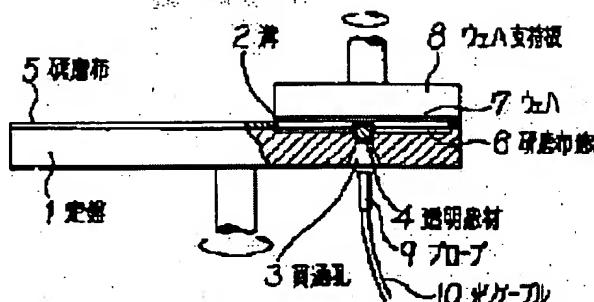
**BEST AVAILABLE COPY****WAFER POLISHING METHOD AND DEVICE THEREFOR**

**Patent number:** JP7052032  
**Publication date:** 1995-02-28  
**Inventor:** SHIRATORI HARUO  
**Applicant:** SUMITOMO METAL MINING CO LTD  
**Classification:**  
- international: B24B37/04; B24B49/12; H01L21/304  
- european:  
**Application number:** JP19930217987 19930810  
**Priority number(s):**

**Abstract of JP7052032**

**PURPOSE:** To provide a polishing method of a wafer and the device therefor in which the thickness of a film can be known without separating a wafer from a surface plate during polishing, and accurate control of the polishing can efficiently be performed.

**CONSTITUTION:** In a polishing method in which a wafer 7 fixed on a wafer supporting plate 8 is pressed against the surface of a polishing cloth 5 stuck on a rotating surface plate 1 and polished while dropping polishing liquid on the surface of the cloth and rotating the wafer by means of the wafer supporting plate 8, the polishing is carried out while judging the polishing condition by observing the light reflecting condition of the polishing surface of the wafer 7 through a transparent window 4 provided between the rotational center of the surface plate 1 and the polishing cloth 5 and the circumferential edge by means of an image pickup device using a charge coupled element, an image display device, and a spectral reflection factor measuring device.



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